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Gender Dependency of Microvascular Complications in Patients of Diabetes Mellitus at a Tertiary Level Hospital in Bangladesh

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Abstract

Background: Diabetes and chronic kidney disease (CKD) are major public health burden in a developing country like Bangladesh. Chronic hyperglycemia in diabetes mellitus (DM) leads to serious microvascular complications.

Aim: To assess gender-based differences in the prevalence and severity of microvascular complications and chronic kidney disease (CKD) among diabetic patients at a tertiary-level hospital in Bangladesh.

Method: This cross-sectional study was conducted at the outpatient department of a tertiary-level hospital in Bangladesh between July 2022 to December 2022 and included 282 diabetic patients (182 males and 100 females). Data were collected using structured questionnaires from medical records, and laboratory test results. Demographic details, clinical characteristics, biochemical parameters, and microvascular complications were assessed. CKD stages were determined using estimated glomerular filtration rate (eGFR).

Results: Out of 282 diabetic patients (182 males, 100 females) with most aged between 40–60 years, the highest age group among males was 50–60 years (38%) and among females that was 40–50 years (36%). Females were more likely to be from urban areas (68% versus 52%, p= 0.024) and showed non-significant trends toward higher rates of hypertension (34.3% versus 26.5%) and family history of diabetes (52% versus 40.9%). Biochemical parameters- including renal status, lipid levels, and glycemic markers were compared between sexes. However, females had significantly lower mean eGFR (22.88 ml/minute/1.73m² versus 27.8 ml/minute/1.73m², p= 0.006), with 46.1% in CKD Stage IV compared to 35.4% of males. Among males, advanced CKD stages were significantly associated with proliferative diabetic retinopathy (p<0.001) and neuropathy (p= 0.008).

Conclusion: These results are clear indication that there is considerable difference in prevalence of different microvascular diabetic complications related to chronic kidney disease between male and female. There are social, economic, and perhaps metabolic reasons for these differences.

Keywords: Chronic Kidney Disease (CKD); Diabetes Mellitus (DM); Diabetic Neuropathy; Diabetic Nephropathy; Diabetic Retinopathy; Gender Difference; Microvascular Complication

Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized

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by persistent hyperglycemia, which progressively damages vital organs including the heart, blood vessels, eyes, kidneys, and nerves [1]. Globally, diabetes is a growing public health concern. According to the International Diabetes Federation (IDF), 537 million adults aged 20-79 years were living with diabetes in 2021, representing 10.5% of the global population, this number is projected to rise to 783 million by 2045 [2]. In Bangladesh, the prevalence of diabetes rose from approximately 5% in 2001 to over 13% in 2017–2018, affecting nearly 8.4 million people [3, 4]. The rate of undiagnosed diabetes was also high, nearly at 6% during the same period [4]. Microvascular complications of diabetes namely- nephropathy, retinopathy and neuropathy are closely linked to disease duration, poor glycemic control, hypertension, and dyslipidemia [5]. Prolonged exposure to high blood sugar leads to structural and functional damage in small blood vessels, triggering these complications [6]. The prevalence of such complications varies widely, reported at 18.0%–57.5% in Asia, 34.3%–48.4% in the Middle East, 47.8% in Nigeria, and 19.5%–42.6% in Ethiopia [7]. One of the most severe complications of diabetes is diabetic nephropathy, a leading cause of chronic kidney disease (CKD) and end-stage renal disease (ESRD) [5]. Diabetic nephropathy results from long-standing hyperglycemia that damages the kidney's microvasculature, impairing its ability to filter waste products [8]. Diabetic retinopathy remains one of the leading causes of preventable blindness worldwide, despite advances in treatment and early detection. It is often the first clinical indicator of microvascular damage in diabetes [9]. Epidemiological data indicate that 8.2% of individuals with visual impairment show signs of retinal microvascular changes, and approximately 40% of type 1 diabetic patients over the age of 40 are affected [10]. Nearly all individuals with type 1 diabetes and over 60% with type 2 diabetes will develop some degree of retinopathy within 20 years of diagnosis [11]. The resulting visual impairment not only lowers quality of life but also complicates diabetes self-management. Diabetic neuropathy is a syndrome that involves the nervous system where both somatic and peripheral components of autonomic nerves are affected. Diabetic neuropathy eventually develops in almost half of all diabetic patients [5]. Diabetes-related cardiovascular dysfunction, sexual dysfunction and poor wound healing are significantly influenced by diabetic neuropathy [5]. Although, little is known about the mechanisms underlying diabetic neuropathy. The likelihood of developing microvascular and macrovascular complications from diabetes may be influenced by gender variations. However, there are very limited research on how diabetic complications vary by gender. The aim of this study was to assess gender-based differences in the prevalence and severity of microvascular complications and chronic kidney disease among diabetic patients attending at a tertiary-level hospital in Bangladesh.

Methods

This hospital-based cross-sectional study was conducted at outpatient department of a tertiary care hospital in Bangladesh between July 2022 to December 2022. A total of 282 confirmed diabetic patients (182 males and 100 females) attending at the outpatient departments were enrolled through consecutive sampling. Inclusion criteria were adults aged 20 years or older with a confirmed diagnosis of diabetes mellitus. Exclusion criteria included patients with acute kidney injury, non-diabetic renal disease, or incomplete data. Data were collected using a pre-structured questionnaire, from review of medical records and recent laboratory investigations. Collected variables included demographic characteristics- age/gender, residence (urban/semi-urban), age of diabetes onset, duration of disease, type of diabetes, family history of DM, comorbidities (e.g., hypertension), biochemical parameters such as- serum creatinine, lipid profile, HbA1c, 24-hour urinary total protein (UTP), and presence of microvascular complications (nephropathy, retinopathy, neuropathy, diabetic foot). CKD staging was done using eGFR based on serum creatinine. Microvascular complications were confirmed through clinical and diagnostic evaluations by relevant specialists. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version-27, with categorical variables compared using Chi-square test and continuous variables assessed with Unpaired t-test. A p-value <0.05 was considered as statistically significant.

Results

Table-1 shows that while most demographic and clinical variables did not differ significantly between male and female diabetic patients, some important findings emerged. The majority of patients in both groups were between 40 and 60 years old, reflecting the typical age range for diabetes diagnosis, with no significant gender difference in age distribution ($p= 0.069$). A statistically significant difference was observed in patient residence: more females were from urban compared to males (68% versus 52%; $p= 0.024$), which may reflect better access to healthcare facilities in urban areas for women or higher urban disease burden. Although not statistically significant, a higher proportion of females reported a family history of diabetes (52% versus 40.9%; $p= 0.072$), which could indicate a stronger genetic predisposition or greater awareness. Similarly, hypertension was more common among female patients (34.3% versus 26.5%; $p= 0.167$), suggesting a potentially greater cardiovascular risk profile in women with diabetes. Type 2 diabetes was predominant in both sexes, and the duration of diabetes was comparable, with no significant gender-based differences ($p>0.05$) (Table- 1).

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Table 1: Gender-wise distribution of demographic and clinical characteristics among diabetic patients (N= 282)

Variables		Male (n=182)		Female (n=100)		p-value*
		n	%	n	%	
Age of patients (years)	20-30	2	1.1	2	2	0.069
	30-40	6	3.3	6	6	
	40-50	43	23.5	36	36	
	50-60	69	38	33	33	
	60-70	51	28	22	22	
	70-80	11	6.1	1	1	
Residence	Urban	73	52	51	68	0.024s
	Semi-urban	67	46	24	32	
Age of onset of diabetes (years)	0 - 20	2	1.6	3	3.9	0.089
	20-30	6	3.9	5	6.9	
	30-40	22	16	16	20.6	
	40-50	72	51.4	37	49	
	50-60	31	22.1	14	18.6	
	60-70	5	3.3	1	1	
	70-80	2	1.65	0	0	
Duration of diabetes (years)	< 10	74	53	43	57.1	0.878
	10-20	55	39	28	37.7	
	20-30	8	5.6	3	4.1	
	> 30	3	2.4	1	1.1	
Type of diabetes	Type- 1	19	13.5	13	16.7	0.46
	Type- 2	121	86.5	62	83.3	
Family history of DM	Yes	74	40.9%	53	52.0%	0.072
	No	107	59.1%	49	48.0%	
Hypertension	Yes	48	26.5%	35	34.3%	0.167
	No	133	73.5%	67	65.7%	

*p-value obtained by Chi-square test, s= significant

It was observed that there were no statistically significant differences in biochemical parameters between male and female diabetic patients. Although mean values varied slightly, none of the comparisons reached significance, indicating broadly similar metabolic profiles across genders. Female patients had slightly lower mean serum creatinine (3.10±2.06 mg/dl versus 3.42±2.19 mg/dl; p= 0.224) and lower 24-hour urinary total protein (UTP) (3.59±0.50 g/day versus 5.57±2.29 g/day; p= 0.543), suggesting marginally better renal function, though not statistically significant. Total cholesterol (TC) and fasting blood sugar (FBS) levels were comparable between the groups, with females showing slightly higher triglycerides (201.79±112.59 mg/dl versus 179.89±91.23 mg/dl; p= 0.085), which approached but did not reach significance. HbA1c levels were also similar (7.13±1.86% in females versus 7.31±1.64% in males; p= 0.385), indicating similar long-term glycemic status (Table- 2).

Data analysis revealed a significant gender difference in the distribution of chronic kidney disease (CKD) stages among diabetic patients based on estimated glomerular filtration rate (eGFR). Although the proportion of patients in Stage V CKD was similar between males (24.9%) and females (26.5%), a larger percentage of females were in Stage IV (46.1% versus 35.4%), while more males were in Stage III (35.9% versus 27.5%). Notably, only males were present in Stage II (4.4%), with no females recorded in this early stage. The mean eGFR was significantly lower in females compared to males (22.88±14.64 ml/minute/1.73m² versus 27.8±16.02 ml/minute/1.73m², p= 0.006), indicating worse overall kidney function among female patients (Table-3).

We evaluated the relationship between CKD stages and microvascular complications among male and female diabetic patients; which highlighting several important patterns, particularly in males. In male patients, proliferative

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diabetic retinopathy significantly increased with worsening CKD stages, with over half (57.9%) of affected males in Stage V ($p<0.001$), indicating a strong association between advanced kidney disease and severe retinal complications. Similarly, neuropathy showed a significant trend with CKD severity among males ($p= 0.008$), with the highest prevalence in Stages IV and V. Diabetic retinopathy also trended toward significance ($p= 0.051$), suggesting a potential link with CKD progression. However, diabetic foot did not show a significant relationship ($p= 0.235$). In contrast, among female patients, none of the complications showed statistically significant associations with CKD stages. Although the distribution patterns mirrored those in males- such as higher rates of proliferative retinopathy and neuropathy in advanced CKD stages; the smaller sample size likely limited statistical power. Notably, 65.4% of females with diabetic foot complications were in Stage IV, hinting at a possible clinical trend despite the non-significant p-value ($p= 0.071$) (Table-4).

Table 2: Comparison of biochemical parameters between male and female patients (N= 282)

Biochemical parameters	Male (n=182)	Female (n=100)	p-value*
24-hour UTP (g/day)	5.57±2.29	3.59±0.50	0.543
Serum creatinine (mg/dl)	3.42±2.19	3.10±2.06	0.224
Serum total cholesterol (mg/dl)	167.39±51.47	174.01±61.16	0.34
TG (mg/dl)	179.89±91.23	201.79±112.59	0.085
FBS (mg/dl)	8.31±3.67	8.10±3.53	0.628
HBA1c (%)	7.31±1.64	7.13±1.86	0.385

*p-value obtained by Unpaired t- test

Table 3: Comparison of CKD stage by eGFR between male and female patients (N= 282)

CKD stages	Male (n=182)	Female (n=100)	p-value*
Stage II	8(4.4%)	0(0.0%)	
Stage III	65(35.7%)	26(26%)	
Stage IV	64(35.2%)	47(47%)	
Stage V	45(24.7%)	27(27%)	
Total	182(100.0%)	100(100.0%)	
eGFR (Mean ± SD) ml/minute/1.73m²	27.8±16.02	22.88±14.64	0.006[s]

*p-value obtained by Unpaired t- test, s= significant

Table 4: Relation of CKD stages with microvascular complications (N= 282)

Microvascular complications*	n	CKD stages				p-value**
		Stage II	Stage III	Stage IV	Stage V	
Male						
Diabetic retinopathy	71	1(1.4%)	19(26.8%)	28(39.4%)	23(32.4%)	0.051
Proliferative diabetic retinopathy	38	0(0.0%)	8(21.1%)	8(21.1%)	22(57.9%)	<0.001[s]
Neuropathy	95	3(3.2%)	25(26.3%)	35(36.8%)	32(33.7%)	0.008[s]
Diabetic foot	44	1(2.3%)	17(38.6%)	11(25.0%)	15(34.1%)	0.235
Female						
Diabetic retinopathy	37	0(0.0%)	8(21.6%)	15(40.5%)	14(37.8%)	0.139
Proliferative diabetic retinopathy	16	0(0.0%)	5(31.3%)	4(25.0%)	7(43.8%)	0.131
Neuropathy	46	0(0.0%)	10(21.7%)	23(50.0%)	13(28.3%)	0.502
Diabetic foot	26	0(0.0%)	5(19.2%)	17(65.4%)	4(15.4%)	0.071

*Multiple response, **p-value obtained by Chi-square test, s= significant

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Discussion

It is well recognized that complications of diabetes, which are particularly dangerous when left untreated, tend to develop gradually and endanger health and quality of life. There is very little information on how diabetes and its consequences differ between genders, and still there are no gender-specific recommendations. Gender differences may have role in the risk of developing microvascular and macrovascular complications from diabetes. In this background, the current study was aimed to evaluate how the prevalence and severity of microvascular complications and chronic kidney disease (CKD) varied by gender among diabetic patients. In this present study, the majority of diabetic patients were within the 40–60 years age group, with 38% of males aged 50–60 years and 36% of females aged 40–50 years, indicating that middle age is the most common period for developing diabetes in both sexes. This aligns with previous findings in a study conducted in Ethiopia, where 56.3 ± 12.8 years was the mean age of type 2 diabetic patients, and over 62.5% had diabetes for more than five years, supporting the observation that microvascular complications typically develop in middle-aged and older individuals [12]. Similarly, Singh SS et al. reported that the burden of microvascular complications increases with age and duration of diabetes, particularly in males, who were more likely to develop multiple complications such as microalbuminuria (p=0.002) [13]. In line with this, Ciarambino T et al. highlighted that while women often develop diabetes at an older age and with higher body mass index (BMI), men are frequently diagnosed younger and face a higher risk of early-onset microvascular complications, especially if glycemic control is suboptimal [14].

In the present study, there were no statistically significant gender differences in biochemical parameters among diabetic patients, although some trends were observed. Male patients had a higher mean serum creatinine level (3.42±2.19 mg/dL) than females (3.10±2.06 mg/dL; p= 0.224), and 24-hour urinary total protein (UTP) was also higher in males (5.57±2.29) compared to females (3.59±0.50; p= 0.543), suggesting a tendency toward greater renal involvement in males. These findings were consistent with the results of Ciarambino T et al., who noted that men with diabetes were more likely to experience early and more severe renal complications due to faster progression of nephropathy [14]. In contrast, female patients in this study showed higher mean triglyceride levels than males (201.79±112.59 mg/dL versus 179.89±91.23 mg/dL; p= 0.085), a trend supported by Gisinger T et al., who reported that diabetic women tend to have worse lipid profiles, likely influenced by hormonal factors and postmenopausal metabolic changes [15]. We observed the glycemic control of the study population by measuring glycated hemoglobin (HbA1c) and fasting blood sugar levels. HbA1c values were comparable between males and females (7.31 ± 1.64% versus 7.13 ± 1.86%; p= 0.385), as were mean fasting blood sugar levels (8.31±3.67 mg/dL in males versus 8.10 ± 3.53 mg/dL in females; p= 0.628). These findings were in line with findings from Mansour A et al., who reported similar glycemic profiles between genders in a Middle Eastern cohort of T2DM patients [16]. Moreover, another related study reported that HbA1c ≥7% significantly increased the risk of microvascular complications (AOR= 2.21; 95% CI: 1.14-4.28), but did not significantly differ by sex [12]. These biochemical patterns, although not statistically significant in this study, reinforce the importance of considering gender-specific risk factors in diabetes monitoring- especially in lipid and renal function management where trends show potential clinical relevance. In the present study, female diabetic patients had significantly lower mean eGFR than males (22.88±14.64 ml/minute/1.73m² versus. 27.8±16.02 ml/minute/1.73m²; p= 0.006), indicating more advanced CKD in females. The most common stage among females was Stage IV (47%), compared to a more even distribution in males between Stage III (35.7%) and Stage IV (35.2%). No females were observed in Stage II, while 4.4% of males were in Stage II; suggesting delayed diagnosis or faster progression of CKD in women. These findings were supported by Solela G et al., who reported a strong association between advanced CKD and older age, longer diabetes duration, and poor glycemic control, particularly in females [12]. Merid F et al. also noted a higher burden of nephropathy among female patients with type 2 diabetes, driven by proteinuria and comorbid hypertension [17]. In this context, Ciarambino T et al. highlighted biological differences and lower renal reserve in women, which may contribute to faster CKD progression when diabetes is present [14]. Similarly, Gisinger T et al. found that gender-related barriers to healthcare access may delay intervention in women, leading to worse renal outcomes [15].

In the present study, a significant association was found between CKD stages and microvascular complications among male diabetic patients, particularly with proliferative diabetic retinopathy (PDR) and neuropathy. PDR was most frequent in Stage V CKD (57.9%, p<0.001), while neuropathy was highly prevalent in both Stage IV (36.8%) and Stage V (33.7%) among males (p= 0.008). Diabetic retinopathy showed a borderline association (p= 0.051). In contrast, no statistically significant associations were observed in females, although trends were similar, with PDR (43.8%) and neuropathy (50.0%) also more common in Stage IV. These findings were consistent with the report of Merid F et al., who found that longer diabetes duration and reduced renal function were significantly associated with neuropathy and retinopathy in T2DM patients [17]. Similarly, Solela G et al. identified CKD progression as a predictor of microvascular complications, especially in older and poorly controlled diabetic patients

[12]. The high proportion of advanced complications in late CKD stages mirrors results from Ciarambino T et al., who emphasized that renal dysfunction exacerbates microvascular damage due to chronic inflammation and vascular stress [14]. Furthermore, Mansour A et al. noted strong genetic and metabolic links between declining eGFR and retinal/neural complications in diabetic populations [16].

Conclusion

This study emphasizes important gender-related differences in diabetic patients, particularly in CKD severity and its link to microvascular complications. Although both sexes had similar metabolic profiles, females more frequently presented with advanced CKD, while males exhibited significant correlations between CKD progression and complications such as proliferative retinopathy and neuropathy. There are social, economic, and perhaps metabolic reasons for these differences. This indicates that a larger and wider study would help us to understand these factors, and devise better patient management.

Conflicts of interest

All authors declared that there was no conflict of interest related to this publication.

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